CBO TESTIMONY

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Current and Projected Navy Shipbuilding Programs

before the
Subcommittee on Seapower and Expeditionary Forces
Committee on Armed Services
U.S. House of Representatives

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Mr. Chairman, Congressman Bartlett, and Members of the Subcommittee, I appreciate the opportunity to appear before you today to discuss the Navy's shipbuilding programs. The Congressional Budget Office's (CBO's) ongoing analysis of those programs, of the Navy's fiscal year 2009 shipbuilding plan, and of available information from the Navy about specific ship programs indicates the following:

- Executing the Navy's most recent 30-year shipbuilding plan will cost an average of about $25 billion a year (in 2009 dollars), or double the $12.6 billion a year the Navy has spent, on average, since 2003.[1]

- The Navy appears to have substantially revised its estimate of the cost of implementing the 30-year shipbuilding plan, bringing its overall estimate into general alignment with CBO's estimates of the past three years.

- CBO's estimates of the Navy's shipbuilding program through the 2009–2013 Future Years Defense Program (FYDP) are about 30 percent higher than the Navy's estimates. In particular, CBO estimates that the DDG-1000 guided-missile destroyer and the CG(X) future cruiser would probably cost significantly more than the Navy currently estimates.

- For the 2009–2020 period, which the Navy's plan describes as the "near term," CBO's estimates for new-ship construction alone are about 15 percent higher than the Navy's.

- The Navy's cost estimates for the 2009 shipbuilding plan beyond 2020, which the Navy's plan describes as the "far term," appear higher than CBO's by about 20 percent. CBO cannot explain the difference between its estimates and the Navy's because detailed information from the Navy explaining the basis of its cost estimates is not yet available.

Overview

In response to Congressional direction, the Department of the Navy began (with the submission of the fiscal year 2003 President's budget) issuing annual reports that describe its 30-year plans for ship construction. In the report released in February 2006, the Navy presented its fiscal year 2007 plan to expand its fleet from 285 battle force ships in 2006 to 313 by 2020 and beyond.[2] In May 2006, CBO issued a study analyzing that plan and estimating its potential costs.[3]

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1. Unless otherwise indicated, the cost figures in this testimony are in billions of 2009 dollars of budget authority, and years are in fiscal years.

2. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2007* (February 2006). Battle force ships are aircraft carriers, surface combatants, submarines, amphibious ships, and some logistics ships.

3. Congressional Budget Office, *Options for the Navy's Future Fleet* (May 2006).

Since May 2006, the Navy has provided two updates to its 313-ship plan, one for fiscal year 2008 and one for fiscal year 2009.[4] There are a number of differences among the plans. The 2007 and 2008 plans both assumed annual costs of $16.1 billion for new construction, but the 2008 plan increased the total number of ships purchased over a 30-year period to 293, compared with 280 for the 2007 plan. The increase of 13 in the number of ships purchased mainly reflected an acceleration of the building of DDG(X) destroyers, which are intended to replace today's Arleigh Burke class of guided-missile destroyers, and a shift in the time period under consideration (the Navy intended to buy more ships in 2037 than in 2007, so moving from a 2007–2036 planning window to a 2008–2037 window increases the number of vessels bought over 30 years). The 2009 plan envisions purchasing three more ships than the 2008 plan—296—and it appears to increase the Navy's estimate of the costs to implement the plan by about 50 percent (see Table 1).

Although the number of ships purchased under the 2008 and 2009 plans differs only slightly, the Navy made significant changes in the numbers of some of the types of ships it would purchase under the two plans. For example, problems and delays in completing the purchase of 55 littoral combat ships, or LCSs (which are small, fast surface combatants designed to focus on specific missions), resulted in a two-year postponement of the planned subsequent purchase of replacements for those ships; thus, fewer of those ships would be acquired by 2038. At the same time, the Navy increased the number of support ships it plans to buy over the next 30 years.

The Navy's 2009 Shipbuilding Plan

On February 6, 2008, the Secretary of the Navy submitted a report to the Congress on the Navy's fiscal year 2009 goals for ship construction over the next three decades. The report maintains the requirement for a fleet of 313 ships that was first outlined in the Navy's fiscal year 2007 report. That fleet is intended to comprise the following battle force ships:

- 11 aircraft carriers;
- 69 guided-missile destroyers;
- 19 guided-missile cruisers;
- 55 littoral combat ships;
- 48 attack submarines;

4. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2008* (February 2007); and Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009* (February 2008).

Table 1.

Comparison of 2007, 2008, and 2009 Navy Shipbuilding Plans

	2007 Plan (2007 to 2036)	2008 Plan (2008 to 2037)	2009 Plan (2009 to 2038)
		Ships Purchased	
Aircraft Carriers	7	7	7
Large Surface Combatants	53	66	69
Littoral Combat Ships	78	85	75
Attack Submarines	51	51	53
Ballistic Missile Submarines	14	14	12
Amphibious Ships	22	20	20
MPF(F) Ships	11	11	9
Support Ships	44	39	51
Total	**280**	**293**	**296**
	Total 30-Year New Construction Costs (Billions of 2009 Dollars)		
Navy's Estimate	483	483	720[a]
CBO's Estimate	624	648	697[a]
	Average Price Per Ship (Billions of 2009 Dollars)		
Navy's Estimate	1.7	1.6	2.4[b]
CBO's Estimate	2.2	2.2	2.4[b]

Source: Congressional Budget Office based on data from the Navy.

Note: MPF(F) = Maritime Prepositioning Force (Future).

a. The estimates include the costs of ballistic missile submarines (SSBNs). For the Navy's estimate, CBO used the cost target for SSBNs in the 2008 plan, updated to 2009 dollars.

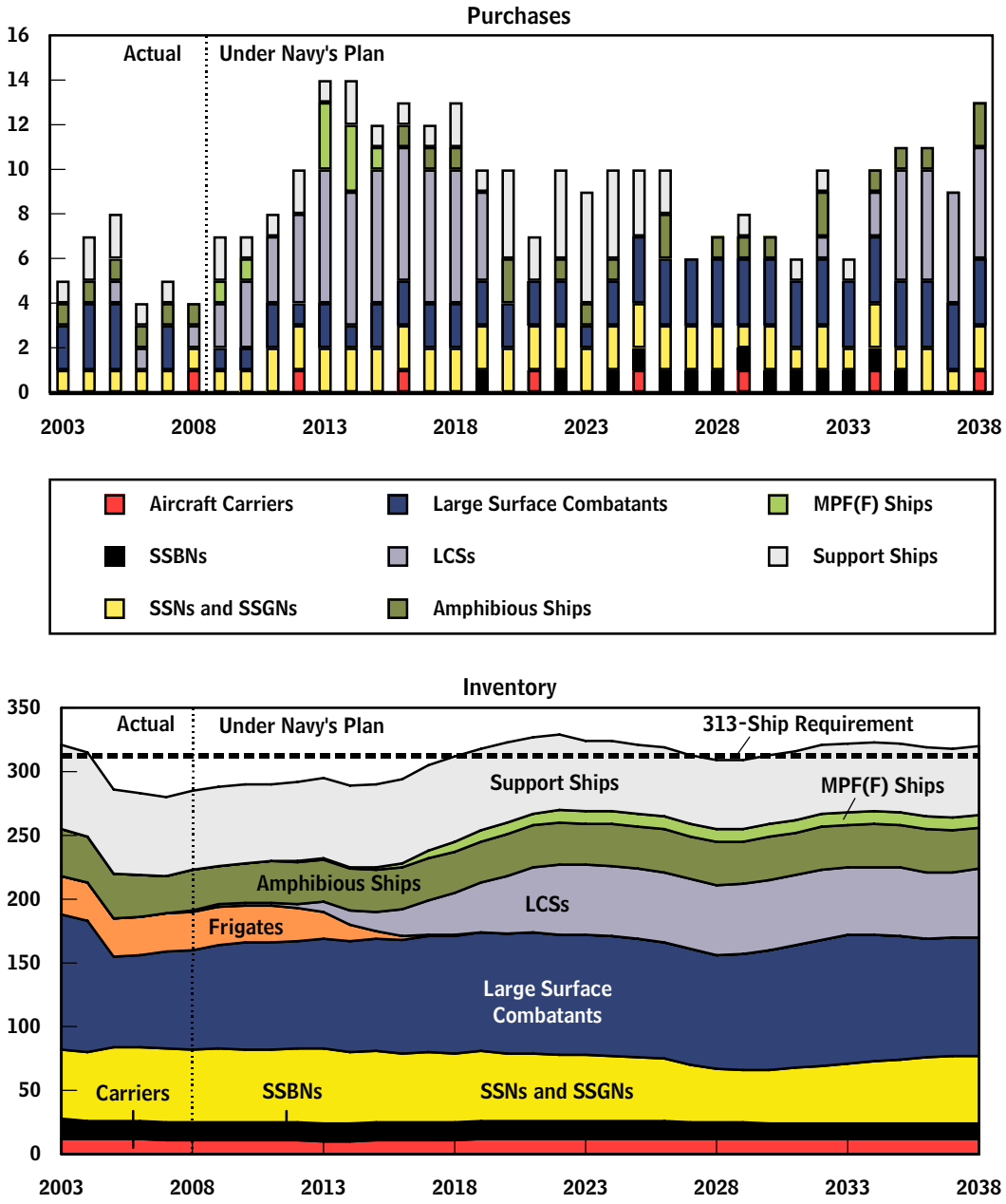
b. The Navy's estimate is $2.43 billion per ship. CBO's estimate is about 3 percent lower.

- 4 guided-missile submarines;
- 14 ballistic missile submarines;
- 31 amphibious ships;
- 12 future Maritime Prepositioning Force (Future), or MPF(F), ships, constituting one MPF(F) squadron; and
- 50 logistics and support ships.

Under the new plan, the Navy would purchase 7 ships in 2009 (see Figure 1) and a total of 47 ships between 2009 and 2013 (the period covered by the Department of Defense's 2009 FYDP). From 2014 to 2038, the Navy would buy another 249 vessels under its long-term plan—for a total of 296 ships, or an average of almost

Figure 1.

Annual Ship Purchases and Inventory Implied by the Navy's 2009 Shipbuilding Plan



Source: Congressional Budget Office based on data from the Navy.

Notes: SSBNs = ballistic missile submarines; SSNs = attack submarines; SSGNs = guided-missile submarines; LCSs = littoral combat ships; MPF(F) = Maritime Prepositioning Force (Future).

10 per year, over 30 years.[5] In the shorter term, the Navy would purchase an average of about 13 ships per year between 2013 and 2018 as production of the littoral combat ships is increased to six per year.

If implemented as described above, the Navy's 2009 plan would keep the fleet at or above the 313-ship goal beginning in 2019 and for most years thereafter. Between 2027 and 2030, the fleet would dip slightly below 313 ships. In contrast, the Navy's 2008 shipbuilding plan reached 313 or more ships in 2016. That difference between the 2008 plan and the 2009 plan reflects primarily the restructuring of the LCS program.

Notwithstanding its achievement of at least 313 ships in 2019, the Navy's 2009 plan would fall short of the service's stated goals for a number of the components of the fleet. The Navy would experience shortfalls in attack submarines (41 in 2028–2030 versus a stated requirement of 48), guided-missile submarines (none after 2028 versus a stated requirement of 4), ballistic missile submarines (12 after 2030 versus a stated requirement for 14), one LPD-17 amphibious transport dock, and two T-AKE logistics ships for the service's future MPF squadron. A shortfall of 15 guided-missile destroyers in meeting an inventory requirement of 88 in the 2007 shipbuilding plan was partially alleviated by increasing the construction rate of DDG(X)s to three per year in the 2008 plan, and the remainder was eliminated in the 2009 plan by assuming a 40-year service life for existing DDG-51s. I will discuss this and other service life issues associated with the Navy's 2009 plan in more detail subsequently.

The attack submarine shortfall in the 2009 plan would result from not buying enough ships at the right times to replace retiring Los Angeles class submarines. To offset the effect that not buying enough submarines would have on the Navy's ability to perform missions, the Navy hopes to reduce the construction time of the Virginia class so that the ships procured in the plan enter the fleet more quickly than is currently assumed, extend the service life of a few Los Angeles class submarines, and, if necessary, deploy a small number of submarines for seven months,

5. Those increased purchases of ships over the next 30 years are necessary to achieve a 313-ship fleet because during the past 16 years, the Navy purchased 99 ships, less than the number needed to sustain a 313-ship fleet. If the notional service life of ships in the fleet is 35 years, the Navy needs to purchase an average of 8.9 ships per year to sustain a 313-ship fleet. During the past 16 years, however, the Navy acquired ships at the rate of 6.2 ships per year.

   That rate of acquisition under the 2009 plan would be well below that experienced in the 1980s, but higher than the average annual purchases since then. During the period spanning 1981 to 1988—in an attempt to build a 600-ship fleet—the Navy purchased 167 ships at an average annual cost of $23 billion (or $1.1 billion per ship) and at a rate of almost 21 ships per year. From 1993 through 2000, the Navy purchased 54 ships at an average annual cost of about $10 billion (or $1.4 billion per ship) and at a rate of 6.8 ships per year. During the period spanning 2001 to 2008, the Navy's ship purchases will total 45—a rate of 5.8 ships annually—with an average annual cost of $12 billion (or $2.1 billion per ship)

one month longer than the traditional six-month deployment. The Navy has not yet determined which combination of those initiatives would best meet its goals.

Under the 2009 shipbuilding plan, the number of ballistic missile submarines (SSBNs) would fall below the stated requirement of 14 beginning in 2027. That shortfall stems from a procurement plan that provides for 12 replacements for the existing Ohio class SSBNs, rather than 14 in the 2007 and 2008 plans. Last year, the Chief of Naval Operations (CNO) stated that because SSBNs in the future will have life-of-the-ship reactors (rather than needing to be refueled at the midpoint of their service life), the submarines will spend less time in dry dock and more time at sea. Therefore, the Navy's requirement for those ships could drop to 12, because that number of ships would be capable of providing the same number of days at sea over their lifetimes as did 14 SSBNs that required refueling. The Navy's procurement plan indicates that the service has adopted the view expressed by the CNO, but the 2009 shipbuilding plan has not changed the stated requirement for 14 SSBNs. However, the Navy's cost estimates for the 2009 shipbuilding plan explicitly exclude the funding needed to replace the Ohio class SSBNs.

The 2009 shipbuilding plan also would not replace the Navy's four current guided-missile submarines (SSGNs). Those ships—former Ohio class ballistic missile submarines that were converted to a guided-missile configuration—are scheduled to be retired in the 2020s. The Navy notes the absence of planned replacements, stating: "Plans for the recapitalization of the OHIO Class submarines that have been converted to SSGN have been deferred until the ships are fully operational and their war fighting utility can be assessed. Should their replacement be required, it will be necessary to integrate their procurement with other ship and submarine recapitalization efforts planned for the post-FY2020 period."[6] That statement—as well as the Navy's retention of an official "requirement" for replacing the existing SSGNs—leaves open the possibility that future 30-year plans may incorporate replacements for those submarines.

Detailed Differences Among the Plans for Fiscal Years 2009, 2008, and 2007

The long-term shipbuilding plan that the Navy submitted to the Congress this year is similar in a number of respects to the fiscal year 2008 plan provided in February 2007.[7] The procurement schedules and quantities purchased for aircraft carriers, attack submarines, guided-missile destroyers, and guided-missile cruisers remain virtually unchanged between the two plans. For other categories of ships, however,

6. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009*, p. 8.

7. For a detailed discussion of the differences between the 2007 and 2008 shipbuilding plans, see Congressional Budget Office, *Resource Implications of the Navy's Fiscal Year 2008 Shipbuilding Plan* (March 23, 2007), pp. 6–7.

the Navy's 2009 plan contains changes relative to its 2008 plan, and the cumulative changes between the 2007 and 2009 plans are greater. During the years common to all three plans (2007 to 2036), the total number of ships purchased does not vary by more than 10, but the numbers and types of ships purchased have changed significantly for every category of ship except for aircraft carriers, attack submarines, and amphibious ships (see Table 2).

- The 2009 plan maintains the increase in procurement quantity for the new guided-missile destroyer, the DDG(X), from two per year (as in the 2007 plan) to three per year (as in the 2008 plan) starting in the mid-2020s.

- The 2009 plan reduces procurement of the new ballistic missile submarine, the SSBN(X), from 14 to 12, causing the inventory of those ships to fall below the Navy's stated requirement permanently beyond 2026.

- The Navy's restructuring of the LCS ship program postpones completing the purchase of 55 of those ships until 2019 (compared with 2016 in the 2007 and 2008 plans). The 2007 and 2008 plans called for the purchase of 34 LCSs between 2007 and 2013, whereas under the 2009 plan, the Navy would purchase only 19. As a result, replacements for the LCS—which is assumed to have a service life of 25 years—would also be purchased later, reducing the number of ships bought in the early 2030s from 40 in the 2008 plan to 23 in the 2009 plan. Presumably, the Navy would eventually buy all 55 LCS replacements.

- Purchase of the ships for the MPF(F) squadron has been delayed by one to two years, compared with the 2007 and 2008 plans. According to the Navy, the delay gives it time to "resolve the concept of operations"—in other words, decide what missions the squadron would perform and under what circumstances.[8] The 2009 plan also reduces the number of MPF(F) T-AKE logistics ships from three to one, pending completion of a study of its concept of operations. The 2009 plan anticipates that those ships will still be needed: "It is expected that the assessment will show that the MPF(F) will need these two T-AKEs."[9]

- The 2009 plan restores the four large combat logistics ships that the 2008 plan had removed from the 2007 plan. Those ships are intended to replace four existing AOE-6 class logistics ships that are scheduled to be retired in the mid-2030s.

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8. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009*, p. 7.

9. Ibid., p. 9.

Table 2.

Ship Purchases in the Years Common to All Three Navy Plans, 2007 to 2036

	2007 Shipbuilding Plan	2008 Shipbuilding Plan	2009 Shipbuilding Plan
		Ships Purchased	
Aircraft Carriers	7	7	7
Large Surface Combatants	53	65	65
Littoral Combat Ships	78	81	66
Attack Submarines	51	51	52
Ballistic Missile Submarines	14	14	12
Amphibious Ships	22	21	20
MPF(F) Ships	11	11	9
Support Ships	44	40	52
Total	**280**	**290**	**283**

Source: Congressional Budget Office based on data from the Navy.

Note: MPF(F) = Maritime Prepositioning Force (Future).

- The 2009 plan increases the number of Joint High Speed Vessels (JHSVs)—fast ferry support ships—that the Navy plans to purchase from three in the 2007 and 2008 plans to seven in the 2009 plan, exceeding the Navy's stated requirement of three. All seven ships count as battle force ships in the fleet inventory. Seven replacements for the JHSVs are also scheduled to be bought in the 2030s, when the first generation of those ships reaches the end of their service life.

- The 2009 plan increases the expected service life of many amphibious ships from 38 to 42 years or more and the service life of guided-missile destroyers from 35 to 40 years, in order to meet inventory requirements. I will discuss this issue in more detail subsequently.

Shipbuilding Costs Under the 2009–2013 FYDP

According to the budgetary information provided in the 2009 shipbuilding plan, the Navy estimates that the costs for constructing new ships, refueling its nuclear-powered vessels, purchasing mission modules for littoral combat ships, and modernizing its large surface combatants—what CBO defines as "total shipbuilding"—would average about $15.6 billion (in 2009 dollars) per year over the 2009–2013 Future Years Defense Program. Funding would be about $14 billion in 2009 and then climb to nearly $18 billion by 2013. That amount is 25 percent greater than the $13 billion that the Navy spent, on average, each year for shipbuilding between 2003 and 2008. According to the Navy's estimates, funding for new construction alone would average $13 billion per year between 2009 and 2013, compared with an annual average of somewhat more than $11 billion between 2003 and 2008.

CBO's estimates for the costs of the Navy's proposed shipbuilding program indicate that the funding needed during the period spanned by the 2009 FYDP could be higher, however. Annual costs within the FYDP for total shipbuilding would average about $21 billion, CBO estimates, which is about 30 percent more than the costs in the Navy's plan and about 60 percent more than the amounts the Navy has spent on shipbuilding recently. CBO estimates that the annual costs for new construction alone could average $18 billion through 2013, or about 35 percent more than in the Navy's plan.

For the 2009–2020 period (which the Navy's plan describes as the near term), CBO estimates that the average annual new shipbuilding costs (excluding ballistic missile submarines) would be more than $20 billion per year. That estimate is about 15 percent greater than the Navy's estimate of $17 billion per year. Including the costs of ballistic missile submarines—if estimates were available from the Navy—could increase that gap.

The largest differences between the Navy's estimates and CBO's estimates within the period of the FYDP are for the costs of the DDG-1000 Zumwalt class destroyer and the CG(X) future cruiser. The Navy plans to buy five DDG-1000s and two CG(X)s between 2009 and 2013. (The first two DDG-1000s were purchased in 2007.) The service estimates the cost of those seven ships at a total of $16.4 billion, whereas CBO's estimate is $28.7 billion.[10]

If CBO's cost estimates for the DDG-1000 and the CG(X) are realized, it would be difficult for the Navy to build a 313-ship fleet without substantially increasing the service's shipbuilding budgets during the years spanned by the 2009 FYDP and beyond. (Those costs are discussed in more detail next.) The difference between CBO's and the Navy's estimates for the cost of the DDG-1000 represents more than 12 percent of the Navy's total shipbuilding budget between 2009 and 2013, or about $10 billion. In the absence of additional resources, paying that difference could require canceling the purchases of either 20 littoral combat ships or most of the MPF(F) ships over the 2009–2013 period.

CBO estimates that the DDG-1000s will cost about 60 percent more than the Navy projects, and CBO's estimate for the costs of the CG(X) is higher than the Navy's because of the relationship between the DDG-1000 and the CG(X) programs. (See pages 18 through 21 for a more detailed discussion of CBO's estimates for those ships.) Currently, funding for the CG(X) in the 2009 FYDP is based on using the DDG-1000 hull to construct the CG(X), while incorporating within that hull more sophisticated radars and combat systems than those carried by the DDG-1000. Thus, higher costs for the DDG-1000 would mean higher costs for the two CG(X)s in the FYDP and for the 17 additional CG(X)s the Navy plans to purchase between

10. See the statement of J. Michael Gilmore, Assistant Director for National Security, Congressional Budget Office, *The Navy's DD(X) Destroyer Program*, before the Subcommittee on Projection Forces of the House Armed Services Committee (July 19, 2005).

2014 and 2023. If CBO's estimate for the cost of the CG(X) is realized, the Navy may find it difficult to purchase two CG(X)s a year between 2015 and 2021, as contained in the 2009 shipbuilding plan. If the service is able to afford only one CG(X) per year, then seven CG(X)s would be either canceled or delayed until the mid- to late 2020s. A delay in CG(X) purchases (rather than a cancellation) could mean that other ship purchases contained in the 2009 plan during the period beyond 2020 might have to be canceled or delayed.

Changes in the Navy's Planned Long-Term Funding for Ship Construction

In submitting last year's shipbuilding plan, the Navy stated that it needed $16.1 billion in funding for new-ship construction ($13.4 billion in 2005 dollars) annually for the period spanning 2008 to 2037. Over the past six years, the Navy has received funding averaging $11.1 billion (in 2009 dollars) for new-ship construction. In building its 2008 plan, the Navy assumed its total obligational authority—the Navy's budgetary topline—would not increase annually at more than the rate of inflation. To accommodate a larger budgetary share for ship construction within a topline receiving no real growth, the Navy made four key assumptions:

- That funding for operation and maintenance in the service's accounts would not grow faster than the overall rate of inflation;
- That funding for research and development—which hit a historical high of about $20 billion in 2006—would fall by $5 billion or $6 billion (although the Navy did not specify over what time frame that would happen) and not increase for the duration of the 30-year plan;
- That any increase in pay and benefits for Navy personnel beyond the general rate of inflation would be offset by reductions in the number of personnel (the Navy's end strength); and
- That ongoing ship programs would experience no cost growth and that the costs of prospective new ships would meet strict cost targets.

The cost targets for ships to be bought after 2013 in the Navy's 2008 shipbuilding plan generally were not based on the costs of either existing ships or cost estimates for notional designs. To develop those targets, the Navy used a "top-down" approach. It allocated the total amount of money it would devote to new-ship construction over 30 years among different types of ships—surface combatants, amphibious ships, attack submarines, ballistic missile submarines, and aircraft carriers—according to their historical shares of Navy funding. The historical share of funding for a particular category of ship was then divided by the number of ships the Navy wanted to buy in that category to calculate the cost target for each category of future ship.

The Navy's 2009 budget illustrates the challenges that the Navy faces in realizing the assumptions listed above. For fiscal year 2009, the Navy is requesting a topline increase of 5 percent in real (inflation-adjusted) terms. The Navy is also requesting an increase of 3 percent in real terms for operation and maintenance spending, 3 percent for military personnel spending, and 11 percent for research and development spending. At the same time, shipbuilding would decrease by 2 percent in real terms. Thus, the 2009 budget request differs from every budgetary assumption the Navy made in constructing its previous shipbuilding plans.

In addition, it appears that the Navy has changed its cost target methodology in developing its 2009 shipbuilding plan. The 2009 plan states that the Navy needs to devote $17.1 billion annually to constructing new ships through 2020 ($15.8 billion in 2007 dollars); the corresponding average annual funding through 2020 in the Navy's 2008 plan was about $16.1 billion ($14.4 billion in 2007 dollars), although the 2009 plan excludes costs for ballistic missile submarines and the 2008 plan includes those costs. The Navy attributes the increase in annual costs between the 2008 and 2009 plans during this near-term period to "the FY 2006 Pension Protection Act, rising material costs, increasing labor rates, and the cost risk associated with developing and building new ship classes. Additionally, minimal first-tier shipbuilding capacity is devoted to commercial business, placing the overhead burden largely on Navy shipbuilding programs."[11]

In the far term, according to Figure 1 in the Navy's 2009 shipbuilding plan, the Navy expects that it will need an average of $25.1 billion ($23.2 billion in 2007 dollars) per year between 2021 and 2038 to fund new construction. (The 2008 shipbuilding plan displayed average annual new-construction costs of about $15 billion for the period spanning 2021–2037.) The 2009 plan lacks any explanation of how the Navy derived the higher costs the plan displays or why those costs differ substantially from the cost targets presented in the 2007 and 2008 shipbuilding plans.

Overall, the Navy's 2009 plan suggests that the Navy will need an average of $22.4 billion ($20.7 billion in 2007 dollars) annually during the next 30 years to pay for new-ship construction alone; but those costs exclude paying for other items included historically in the total shipbuilding budget. For example, they exclude funding for nuclear refuelings of aircraft carriers and submarines, mission modules for littoral combat ships, and modernization programs for existing surface combatants. Notably, the 2009 plan also excludes funding to replace the Navy's ballistic missile submarines, which were included in the cost projections the Navy provided in its 2007 and 2008 shipbuilding plans. The 2009 plan states: "The replacement program for the OHIO class Ballistic Missile submarines is a strategic issue that merits immediate attention. Absent additional resources to recapitalize

11. Department of the Navy, *Report to Congress on Annual Long-Range Plan for Construction of Naval Vessels for FY 2009*, p. 11.

this national strategic capability, the Navy will be unable to concurrently replace the existing OHIO class submarines and the balance of its force structure requirements in accordance with this shipbuilding plan."[12] Including the Navy's estimates for new-ship construction and for the costs of 12 SSBNs (from its 2008 plan), as well as CBO's estimate for the other items listed immediately above, the Navy's total shipbuilding budget could average about $25.9 billion per year for the next 30 years, an increase of around 40 percent over the comparable estimates in the 2007 and 2008 plans and more than double the average for total shipbuilding contained in the budgets of the past six years.

CBO's Estimate of the Costs of the 2009 Shipbuilding Plan

Buying a total of 296 ships over the 2009–2038 period—or an average of about 10 ships per year—would require an average annual shipbuilding budget of $23.2 billion for new construction alone, including the costs for new ballistic missile submarines, CBO estimates (see Table 3). (If SSBNs were excluded, the Navy would need to spend an average of $20.4 billion annually on new-ship construction.) That amount is less than the $24.0 billion in new construction (including SSBNs) that the Navy expects its shipbuilding plan to cost and more than double the $11.1 billion per year that the Navy spent on new-ship construction between 2003 and 2008. Including the costs of refueling nuclear-powered aircraft carriers and submarines would raise CBO's estimate to $24.4 billion a year, on average, over the next 30 years (see Figure 2).

Those figures exclude costs to modernize existing cruisers and destroyers and to buy the mission modules that are intended to provide much of the combat capability of littoral combat ships. The Navy plans to fund those items from accounts other than the ones normally associated with ship construction. However, such modernization programs have been funded from shipbuilding accounts in the past; and in other new-ship programs (such as for the DDG-1000 Zumwalt class destroyer), combat capability is included in a ship's cost and funded as part of the ship's construction. Paying all of the expenses of new-ship construction (including constructing new ballistic missile submarines to replace the Ohio class SSBNs), nuclear refuelings, modernization of surface combatants, and mission modules for LCSs would require average funding of $25.2 billion annually, CBO estimates.

Although CBO's estimates for the 2009 plan are higher than the Navy's through 2020, the Navy's estimates for the years beyond 2020 appear higher than CBO's. Funding for new-ship construction beyond 2020 would average $20.9 billion a year (excluding SSBNs), CBO estimates, or about $4 billion per year less than the amounts that the Navy shows in its display projecting new-ship construction costs during the 2021–2038 period. CBO hopes to receive information from the Navy

12. Ibid., p. 8.

Table 3.

Average Annual Shipbuilding Costs

(Billions of 2009 dollars)

	New-Ship Construction (Excluding SSBNs)	New-Ship Construction (Including SSBNs)	New-Ship Construction, SSBNs, and Nuclear Refuelings	New-Ship Construction, SSBNs, Nuclear Refuelings, LCS Mission Modules, and Surface Combatant Modernization
Navy's Actual Spending, 2003 to 2008	11.1	11.1	12.4	12.6
Costs Under the Navy's 2009 Long-Term Shipbuilding Plan				
Navy's estimate	22.4	24.0 [a]	25.1 [b]	25.9 [b]
CBO's estimate	20.4	23.2	24.4	25.2
Memorandum:				
Navy's Estimate of Costs Under the 2007 and 2008 Plans	n.a.	16.1	17.2 [b]	18.0 [b]

Source: Congressional Budget Office based on data from the Navy.

Note: SSBN = ballistic missile submarine; LCS = littoral combat ship; n.a. = not applicable.

a. The Navy's estimate for new-ship construction plus the Navy's cost target for SSBNs under the 2007 and 2008 shipbuilding plans.

b. The Navy's estimate for new-ship construction and cost target for SSBNs plus CBO's estimate for the additional costs.

providing the details underlying its cost estimates for ship programs over the 30-year period.

According to CBO's calculations, the Navy's 2009 shipbuilding plan would cost about $2.5 billion more per year to carry out than the 2008 plan. Some of that increase is attributable to price escalation of about 3.5 percent from 2008 dollars to 2009 dollars. The remainder of the increase is attributable to higher ship prices (such as for the LCS), changes in the numbers and types of ships being purchased, and a change in how CBO incorporates higher inflation in the shipbuilding industry into its projection, which is discussed in more detail in the next section.

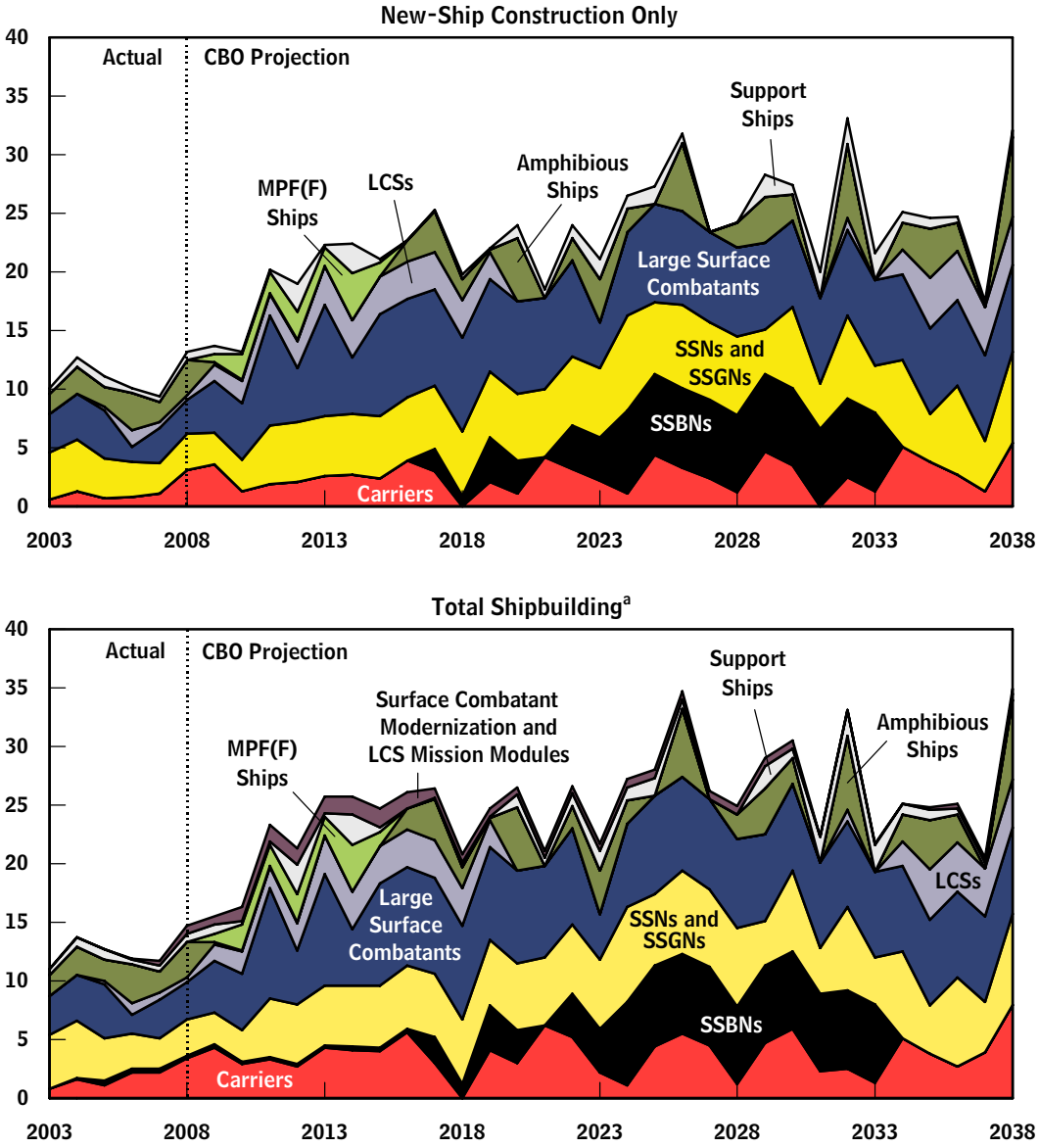
Inflation in Shipbuilding

An important component of the Navy's and CBO's cost analyses is the role of inflation in the construction of naval vessels. The Navy has examined the inflationary component of past cost increases in shipbuilding programs and concluded that the overall figure ("inflator") that the Department of Defense (DoD) uses to project cost increases for its procurement programs has underestimated the

Figure 2.

Annual Costs Implied by the Navy's 2009 Shipbuilding Plan

(Billions of 2009 dollars)



Source: Congressional Budget Office based on data from the Navy.

Notes: SSBNs = ballistic missile submarines; SSNs = attack submarines; SSGNs = guided-missile submarines; LCSs = littoral combat ships; MPF(F) = Maritime Prepositioning Force (Future).

Amounts for 2006 exclude supplemental funding related to Hurricane Katrina.

a. Includes costs for new-ship construction, refuelings of nuclear-powered ships, programs to modernize existing large surface combatants, and mission modules for littoral combat ships. The modernization of surface combatants and the mission modules for LCSs are expected to be funded from Navy accounts other than those traditionally associated with shipbuilding.

inflation that has actually occurred in the naval shipbuilding industry over the past decade by about 1.8 percentage points per year, on average. The Navy provided CBO with a composite inflator that reflects the growth in labor and material costs that the industry has experienced in the past and that the Navy expects it to experience through at least 2013. That inflator is an average of about 1.4 percentage points higher per year—from 2009 through at least 2016—than the price increases DoD expects for its procurement programs overall: about 3.5 percent for shipbuilding versus 2.1 percent for defense procurement programs as a whole. The Navy incorporated that higher rate of inflation in its budget request for 2009 and the associated Future Years Defense Program. In both the Navy's and CBO's analyses, the higher rate of inflation produces real growth in the future costs of ships. For example, a ship that costs $2.5 billion to build in 2009 will cost $3.2 billion (in 2009 dollars) to build in 2025.

In its analysis of the Navy's 2007 and 2008 shipbuilding plans, CBO assumed that cost growth in the shipbuilding industry would continue to be higher than average for many years and then would gradually revert to the level of general inflation for DoD procurement programs by 2025. In its analysis of the 2009 plan, CBO assumed that the higher rate for ships would continue throughout the analysis, in part because CBO does not have an analytic basis for determining when and how the difference between the shipbuilding inflator and the DoD procurement inflator would disappear.

At the same time, it should be noted that inflation in shipbuilding costs cannot forever continue to grow at a rate faster than that of procurement programs overall (or the economy as a whole). If that were to happen, eventually the price of ships would outstrip the Navy's ability to pay for them, even in very small numbers. In addition, for the purposes of comparison, if in this analysis CBO had used the same assumption as in its previous analysis—that higher shipbuilding inflation reverts to the level of DoD procurement programs by 2025—then the total costs for shipbuilding would be $24.1 billion per year and new construction alone would total an average of $22.2 billion per year, or about 5 percent less than CBO's current estimates, in 2009 dollars.

Individual Ship Programs

To estimate the costs of the 2009 shipbuilding plan, CBO used Navy data on actual costs for ships now under construction and historical relationships between the cost and weight of ships (as discussed in more detail below). To apply those relationships to ships for which the Navy has yet to develop even a notional design—such as the prospective replacements for Arleigh Burke class destroyers and the Ohio class ballistic missile submarines—CBO had to make assumptions about the sizes and capabilities of future ships.

Aircraft Carriers

Under the 2009 shipbuilding plan, the Navy's requirement is for 11 aircraft carriers, which is unchanged from the 2007 and 2008 plans. To maintain that size force, the Navy would buy seven CVN-78 Gerald R. Ford class aircraft carriers over the 2009–2038 period. Building them every four or five years, the Navy would maintain at least 11 carriers through 2038, with the exception of 2013 and 2014, when the force would drop to 10. That decline occurs because under the shipbuilding plan, the CVN-65, the *Enterprise*, will be retired at the end of its service life in 2013 and the CVN-78 Gerald R. Ford class nuclear-powered aircraft carrier that will replace it will not be commissioned until 2015. In the event of construction delays in the CVN-78 program, the period during which the Navy would have 10 carriers would be longer.

To estimate the cost of the new CVN-78 class aircraft carriers, CBO relied on the Navy's estimate for the CVN-78 and increased the cost to account for historical cost risk in procurement programs and for the higher rate of inflation expected in the shipbuilding industry.[13] (A comparison to the cost of the CVN-77 Nimitz class carrier adjusted for historical cost growth would have produced a similar estimate.) The first ship of the new CVN-78 class would require substantial funding for nonrecurring detail design, but subsequent ships would need little such funding. CBO estimates that the seven carriers in the Navy's 2009 shipbuilding plan would have an average cost of about $11.2 billion each (see Table 4). Under the 2007 and 2008 plans, the Navy's cost target for aircraft carriers was $10.5 billion. CBO does not have enough information to calculate what the Navy estimates the average cost of its new class of aircraft carriers would be under the 2009 plan.[14]

The Navy has estimated the cost for the first CVN-78 carrier, but CBO believes that the Navy's cost estimate is optimistic, for several reasons. First, in its budget submission to the Congress, the Navy indicates that the first CVN-78 will cost about $10.3 billion in 2009 dollars, including about $2.4 billion in nonrecurring engineering and design costs. The Navy asserts that the construction time and cost of the first CVN-78 will be less than those of its predecessor ship, the CVN-77, *George H. W. Bush*. In contrast, CBO estimates that the CVN-78 will cost about $11.2 billion, allowing for the historical cost growth that has affected shipbuilding programs at the CVN-78's stage of construction over the past 30 years. If, however, the CVN-78 experiences cost growth similar to that of other lead ships that the Navy has purchased in the past 10 years, costs could be much higher still.[15]

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13. Cost risk is the tendency of defense procurement programs to experience cost increases unrelated to inflation.

14. CBO's estimate of the costs of aircraft carriers in the Navy's 2008 shipbuilding plan was almost identical to the Navy's cost target. CBO's higher estimate under the 2009 plan is the result of assuming that higher inflation in the shipbuilding industry will continue through 2038.

15. The LPD-17, the SSN-774, the SSN-775, and the LCS-1 have experienced cost increases of about 80 percent, 11 percent, 25 percent, and 100 percent, respectively.

Table 4.

Comparison of the Navy's Cost Targets and Cost Estimates, and of CBO's Estimates of the Costs of Major New Ships

(Billions of 2009 dollars)

	Navy's Average per-Ship Cost Target Under Its 2007 and 2008 Plans[a]	Average per-Ship Cost over the 2009-2038 Period	
		Navy's Cost Estimate Under Its 2009 Plan	CBO's Estimate[b]
CVN-78 Gerald R. Ford Class Aircraft Carriers	10.5	n.a.	11.2
DDG-1000 Zumwalt Class Destroyers	2.4[c]	2.5[c]	4.0[c]
CG(X) Cruisers	3.0	n.a.	4.2
DDG(X) Destroyers (Replacement for Arleigh Burke class)	1.7 [d]	n.a.	2.6
Virginia Class Attack Submarines	2.4	2.4	2.9
SSBN(X) Ballistic Missile Submarines (Replacement for Ohio class)	3.4	n.a.	7.0
Amphibious Ships	1.6	n.a.	2.8

Source: Congressional Budget Office.

Note: n.a. = not available in the Navy's 2009 plan.

a. Based on a briefing by the Navy for CBO and the Congressional Research Service, February 10, 2006, updated for current-year dollars.

b. CBO's estimates are generally based on historical relationships between cost and weight for individual types of ships; they also incorporate the higher inflation that the naval shipbuilding industry has experienced (compared with inflation in other Department of Defense procurement programs).

c. Average per-ship costs for the total program.

d. The Navy's 2008 plan added 12 DDG(X)s and removed 4 large logistics ships compared with the 2007 plan, but the 2008 plan indicated that overall shipbuilding costs would not change. CBO assumed that the Navy's per-ship cost target for the DDG(X) was therefore reduced from $2.1 billion to $1.7 billion, reflecting both the increased number of ships to be purchased and the increase in funding that could be allocated to purchasing those new destroyers from the reduction in purchases of logistics ships.

Second, Navy officials have told CBO that the confidence level of their estimate for the lead CVN-78 is below 50 percent, implying a more than 50 percent chance that the costs for the ship will be higher than the Navy's estimate (and a less than 50 percent chance that they will be lower). Finally, a number of critical technologies to be incorporated in the CVN-78 (such as the new electromagnetic catapult system for launching aircraft) remain under development. Difficulties in completing their development could arise and increase costs.

Surface Combatants

The Navy's and CBO's estimates for the costs of the DDG-1000 program and the first two CG(X)s differ substantially. All of the DDG-1000s and most of the CG(X)s will be purchased by 2021, which partly explains why CBO's estimates for new-ship construction are higher than the Navy's through 2020. The Navy's purchase of 55 littoral combat ships would be completed before 2020. Starting in 2022, the Navy would begin purchasing replacements for the DDG-51 class destroyer, designated in the plan as DDG(X).

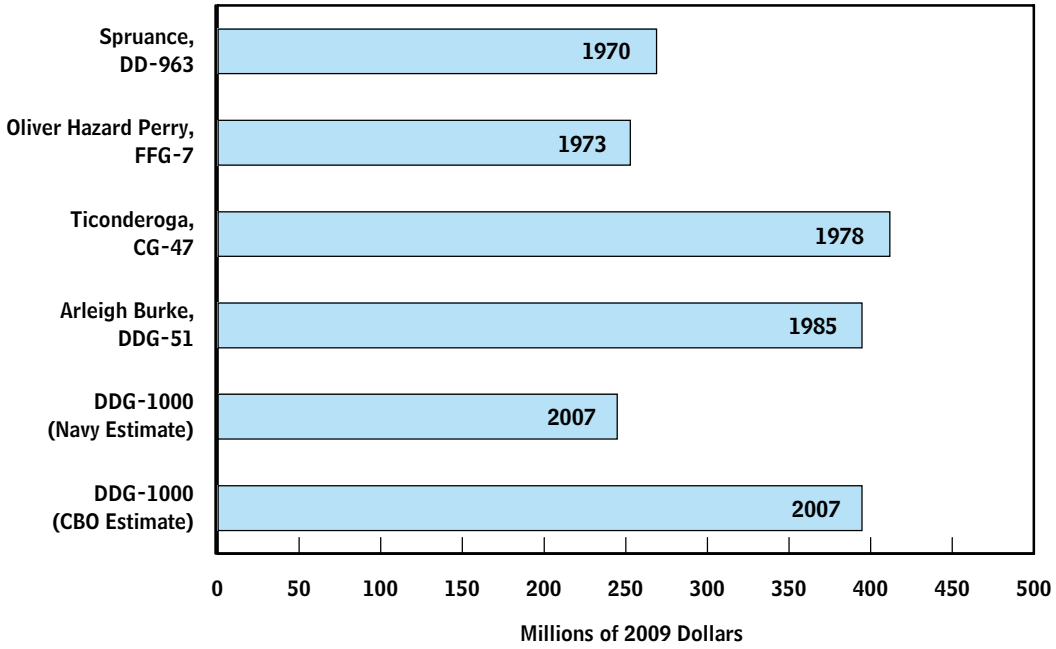
DDG-1000 Guided-Missile Destroyer. The Navy plans to buy one DDG-1000 Zumwalt class destroyer each year from 2009 to 2013, in addition to the two authorized in 2007. The service's 2009 budget suggests that the Navy expects the first two ships to cost $3.2 billion each and the following five to cost an average of $2.2 billion each, which is a cost increase of about $200 million per ship for the last five ships compared with the cost in the Navy's 2008 budget. CBO, by contrast, estimates that the first two DDG-1000s would cost $5.0 billion apiece, and the next five would cost an average of $3.6 billion each.

The Navy's estimate for the two lead-ship DDG-1000s prices the ship at about $250 million (in 2009 dollars) per thousand tons of lightship displacement, which is the weight of the ship minus its crew, fuel, ammunition, and stores. In comparison, the lead ship of the DDG-51 class destroyer cost about $390 million per thousand tons, and the lead ship of the Ticonderoga class cruiser cost more than $400 million per thousand tons (see Figure 3). CBO uses the DDG-51 lead-ship cost as its basis for estimating the cost of the lead ship of the DDG-1000 class, adjusting for the size of the ship.

The Navy has asserted that the basis for CBO's estimate may not be valid because the DDG-51 had a number of problems in the early stages of its construction that should not be expected to occur during the construction of the first DDG-1000s. In particular, the design of the lead DDG-51 was disrupted and delayed because a new design tool being used at the time was incomplete and not well understood. It had to be abandoned and the design restarted using more traditional methods. The design of the lead DDG-51 was thus about 20 percent complete when construction began. In comparison, according to the Navy, the design of the DDG-1000 is progressing far more smoothly; the Navy expects to have the design 85 percent complete when construction begins this summer. In addition, the DDG-51 is a smaller,

Figure 3.

Cost per Thousand Tons for the Lead Ship of Various Classes of Surface Combatants



Source: Congressional Budget Office based on data from the Navy.

Notes: The years shown here indicate the year in which each lead ship was authorized.

Costs are per thousand tons of lightship displacement (the weight of the ship itself without its crew, materiel, weapons, or fuel).

more densely built ship and, therefore, the Navy believes that on a ton-for-ton basis, it has been more difficult to build than the DDG-1000 class is going to be.

Although the Navy may not encounter the same problems constructing the lead DDG-1000s as the service did in constructing the lead DDG-51, it is CBO's view that the Navy is likely to encounter other problems that will increase the costs of the DDG-1000 and delay its construction. As Navy officials have stated, lead ships are often very difficult to build and typically have many problems in construction. The problems with the first littoral combat ships (for which costs doubled) and the lead ship of the LPD-17 class amphibious transport dock (for which costs increased by 80 percent and construction time more than doubled) illustrate the difficulties the Navy has encountered recently in constructing lead ships.[16] Both the LCS and the LPD-17 are much less complex technologically than the DDG-

16. Problems with the LCS included a change in construction standards, other design changes, and mistakes made by the contractor. The LPD-17 has suffered from an incomplete design before construction began, difficult integration of new technologies on the ship, and higher labor and material costs.

1000 will be. And Navy officials have stated that the Virginia class submarine program was about at the same point in its design as the DDG-1000 will be when construction of those new submarines began. Nevertheless, the cost of the first two ships of the Virginia class exceeded their budget by an average of 17 percent. Moreover, the DDG-1000 program is incorporating 10 major new technologies into the lead ship of the class compared with the technologies used in the previous-generation DDG-51 destroyer. Those technologies include electric drive and a distributed power system, a tumblehome hull (one in which the sides of the ship slope outward to increase stealthiness), an advanced gun system, new radars, and composite materials and stealthy coatings for the deckhouse. In the past, the Navy typically introduced three or four major new technologies into a new class of surface combatant.

Comparing the Navy's estimate for two additional DDG-51s and the Navy's estimate for the seventh DDG-1000 to be purchased in 2013 illustrates the risk for cost growth in the latter program. Last year, the Navy stated that if the Congress authorized and bought two new DDG-51s in 2008—ships that would have the benefit of substantial efficiencies and lessons learned because of the 62 ships that were built previously—the cost would have been between $3.1 billion and $3.2 billion, or about $1.6 billion apiece in 2009 dollars. At the same time, in its fiscal year 2009 budget submission to the Congress, the Navy stated that the cost to build the seventh DDG-1000 in 2013 will be about $2.4 billion in 2013 dollars. Deflating the cost of the seventh DDG-1000, using the inflation index provided to CBO by the Navy for shipbuilding, brings the Navy's estimate for that ship to about $1.9 billion in 2009 dollars. The lightship displacement of the DDG-1000 is about 5,000 tons (or more than 50 percent) greater than the lightship displacement of the DDG-51s under construction today. In effect, the Navy's estimates imply that those 5,000 extra tons, as well as the 10 new technologies being incorporated into the DDG-1000 class, will add only 15 percent, or about $300 million, to the ship's cost.

CG(X) Future Cruiser. The Navy intends to begin buying a new missile defense surface combatant, the CG(X) cruiser, in 2011. CBO's estimates for the first two ships of the class are about double the Navy's estimates. CBO assumed that a CG(X) would use the same hull as a DDG-1000. The Navy's budget estimates for the 2011 and 2013 cruisers are based on the same assumption; the Navy expects those ships to cost $2.8 billion and $2.5 billion, respectively. The Navy last year conducted an Analysis of Alternatives (AoA) to determine what capabilities the CG(X) will have. Results of that analysis have not yet been released, but a version of the CG(X) built using the DDG-1000 hull is only one of the options considered in the AoA. The Navy says it is studying other options that would be larger and more capable than a CG(X) built using the DDG-1000 hull, including ships using nuclear propulsion (see Box 1). The Navy does not appear to be considering a ship smaller than the DDG-1000 as the basis for the CG(X). Any design for the CG(X) larger than the DDG-1000 is likely to be substantially more expensive than the

Box 1.

A Nuclear-Powered Cruiser

The 2008 National Defense Authorization Act directed that future Navy aircraft carriers, submarines, and cruisers should be nuclear-powered. Building a future nuclear cruiser, a CGN(X), would probably cost more than what the Congressional Budget Office (or the Navy) has currently estimated for the CG(X). A Navy report on the cost-effectiveness of nuclear propulsion estimates that the additional cost to install nuclear propulsion in a conventionally powered surface combatant would be approximately $700 million. If a CGN(X) has to be much larger than the DDG-1000, then there would probably be additional costs. Press reports have indicated that a CGN(X) could displace as much as 23,000 to 25,000 tons, or 60 percent to 70 percent more than the DDG-1000. (A large ship may be necessary, for example, if the Navy were to use for the CGN(X) one of the reactors now used in the CVN-78 class of aircraft carrier because, according to the Navy, that reactor's size, weight, and supporting systems could not be accommodated within a hull the size of the DDG-1000.) If that is the case, the larger, nuclear-powered CGN(X) could cost much more than the DDG-1000.

DDG-1000. Using the DDG-51 as an analogy, CBO estimates that the lead CG(X)s will cost $5.2 billion. The average cost for the class would be about $4.2 billion apiece, assuming that the CG(X) is conventionally powered and uses the DDG-1000 hull. CBO also assumed, consistent with the DDG-1000 program, that two shipyards would build the CG(X)s.

Moreover, CBO's estimate for the cost of the CG(X) may be optimistic. The last time the Navy reused a hull design for a new class of surface combatants was in the 1970s, when the service built the Spruance class destroyers and Ticonderoga class cruisers. Both ship classes shared the same hull but were designed for different missions. The Spruances were general-purpose destroyers used to escort other Navy ships in the event of war and were designed in particular for antisubmarine warfare. The Ticonderoga class cruisers incorporated the Aegis antiair combat system, the SPY-1 radar, and surface-to-air missiles to counter the threat to Navy carrier battle groups posed by Soviet naval aviation. Reflecting its more complex combat systems, the cost per thousand tons of the lead Ticonderoga was more than 60 percent higher than the cost of the lead Spruance, notwithstanding their many common hull and mechanical systems.

DDG(X) Future Guided-Missile Destroyer. The Navy's 313-ship plan would also maintain a fleet of 62 DDG-51s. CBO assumed that those ships would be modernized and would serve for about 40 years, consistent with the Navy's plan, which calls for the purchase of the first replacement—a DDG(X)—in 2022. For its analysis, CBO assumed that the new DDG(X) would be somewhat larger than the DDG-51 (which displaces about 9,200 tons at full load) but smaller than the DDG-1000 (which is intended to displace about 14,500 tons at full load). Specifically, CBO assumed that the DDG(X) would have a full-load displacement of about 11,000 tons and could not carry both of the advanced gun systems of the DDG-1000. In CBO's projection, those replacement destroyers would have an average cost of about $2.6 billion apiece if they were bought at a rate of three per year—the same cost per thousand tons as today's Arleigh Burke destroyers.[17] The Navy's implicit cost target for DDG replacements in its 2008 plan was much lower: $1.7 billion each.[18] In the 2009 shipbuilding plan, the Navy did not indicate what it estimates DDG(X)s would cost.

Modernizing DDG-51 Destroyers. The 40-year service life assumed for the DDG-51 Arleigh Burke class destroyers in the Navy's 2009 shipbuilding plan is a significant change from the 35-year service life assumed in the 2007 and 2008 shipbuilding plans. Historical evidence suggests that the Navy may be optimistic to assume that those destroyers can serve effectively for 40 years. The average retirement age of the last 18 classes of cruisers, destroyers, and frigates was below 35 years, and many were retired at 25 years or less (see Table 5). When the DDG-51 class was first built, the service life for which it was designed was 30 years.

Generally, the Navy has considered surface combatants to have become obsolete when their installed combat systems were deemed no longer effective to counter the threats they would face in the event of war. The hull and mechanical systems of the ships have usually had service life remaining in them, though additional resources would have been required to maintain them in good working order. Currently, the Navy plans a modernization program that focuses mostly on the DDG-51's hull and mechanical systems at an average cost per ship of about $100 million. On the basis of historical experience, it is possible that the combat systems of the DDG-51s may have to be upgraded twice in order for those ships to serve in the fleet for 40 years. The costs for upgrading those combat systems are not included in the Navy's shipbuilding plan. In comparison, the Navy plans to spend more than $200 million per ship on modernizing the remaining CG-47

17. Buying more of a given ship in the same year reduces the cost per ship because it allows a shipyard's fixed overhead expenses to be spread among more ships.

18. The cost target for DDG(X)s in the Navy's 2007 plan was $2.1 billion. However, the Navy added 12 DDG(X)s to the 2008 plan and removed four logistics ships, while stating that the overall costs of the plan were unchanged. CBO therefore assumed that the resulting cost target for the DDG(X) was reduced from $2.1 billion to $1.7 billion, reflecting both the increased number of ships to be purchased and the increase in funding that could be allocated to purchasing those new destroyers from the reduction in purchases of logistics ships.

Table 5.

Average Retirement Age of Surface Combatant Classes

Ship Class	Average Retirement Age (Years)	Reason(s)
CG-47 (Non-VLS)	20	Budgetary; not as capable as other ships
CG-26	28	Budgetary
CG-16	30	Budgetary
CGN-38	17	Budgetary
CGN-36	24	Budgetary
CGN-35	27	Budgetary
CGN-9	32	Budgetary
DD-963 (VLS)	25	Budgetary; not as capable as other ships
DD-963	25	Budgetary; not as capable as other ships
DD-931	29	End of service life
DDG-993 (Non-VLS)	17	Budgetary; not as capable as other ships
DDG-37	30	End of service life
DDG-2	26	End of service life
FF-1052	17	End of service life; limited capability
FF-1040	22	End of service life; limited capability
FF-1037	25	End of service life; limited capability
FFG-7	18	Budgetary; end of service life
FFG-1	21	End of service life

Source: Congressional Budget Office based on data from the Navy.

Notes: The reasons cited for retirement are the Navy's descriptions.

CG = guided-missile cruiser; VLS = vertical launch system; CGN = nuclear-powered guided-missile cruiser; DD = destroyer; DDG = guided-missile destroyer; FF = frigate; FFG = guided-missile frigate.

Ticonderoga class cruisers, including their combat systems, so that those ships can serve effectively for at least 35 years. CBO's projections assume one round of DDG-51 modernizations. CBO estimates the per-ship cost of such modernizations, including the combat systems, would be at least comparable to that of the CG-47 program, or more than $200 million apiece.

Littoral Combat Ship. The Navy's 2009 shipbuilding plan envisions building 55 littoral combat ships between 2005 and 2019. Because those ships are assumed to have a service life of 25 years, the Navy would need to begin procuring their replacements in 2032. The LCS differs from the Navy's existing and previous warships in that the program is divided into two components: the sea frame and mission modules. The sea frame (the ship itself) will be built with the ability to switch mission modules (combat systems) depending on which mission the ship is intended to carry out at a given time. Currently, the Navy expects to use three types of mission modules: for countermine warfare, antisubmarine warfare, and anti-surface-craft warfare. The Navy expects to buy 64 mission modules for the 55-ship program.

The Navy intends for the LCS to be a relatively affordable ship that will be relatively simple to design and build. Each sea frame was originally expected to cost about $260 million in 2009 dollars (or $220 million in 2005 dollars). The Navy's 2009 budget provides for the purchase of 18 LCSs during the 2009–2013 period at an average cost of about $450 million per sea frame, or 11 fewer than the 2008 plan envisioned for the same time period. In the summer of 2007, the Navy requested that the cost cap for the fifth and sixth LCSs be raised to $460 million. Based on the effects of a higher production rate and learning in the construction process from the first to subsequent ships, that figure suggested that the total construction cost of the first ships would be around $600 million each. In the 2009 budget, the Navy estimates the cost of LCS-1 at $631 million and LCS-2 at $636 million.

Historical experience indicates that cost growth in the LCS program was likely. In particular, historical cost-to-weight relationships using the lead ship of the FFG-7 Oliver Hazard Perry class frigate as an analogy indicate that the Navy's original cost target for the LCS of $260 million in 2009 dollars (or $220 million in 2005 dollars) was optimistic. The first FFG-7 cost about $670 million in 2009 dollars to build, or about $250 million per thousand tons, including its combat systems. Applying that metric to the LCS program suggests the lead ships would cost about $600 million apiece, including the cost of one mission module. Thus, in this case, the use of an historical cost-to-weight relationship produces an estimate that is less than the actual costs of the first LCSs to date but substantially greater than the Navy's original estimate.

Based on the actual costs the Navy is incurring for the LCS program, CBO estimates that the first two LCSs could cost about $700 million each, including outfitting and postdelivery and various nonrecurring costs associated with first ships of a class, but excluding mission modules. That estimate is consistent with the estimate CBO provided to this Subcommittee last summer. However, as of December 2007, LCS-1 was 79 percent complete and LCS-2 was 65 percent complete. Thus, additional cost growth is possible, and CBO's estimate reflects that cost risk.

Overall, CBO estimates that the LCSs in the Navy's plan would cost about $550 million each, on average, excluding mission modules. That estimate assumes that the Navy selects one of the two existing designs and makes no changes. As the program advances with a settled design and higher annual rates of production, average ship costs would probably decline, CBO estimates. If the Navy decides to make changes to that design in building future ships, however, the costs of those ships could be higher than what CBO estimates now.

The relatively simple design of the LCSs and the substantial cost increases that have occurred in the program suggest that the Navy may also have trouble meeting its cost targets for the larger, much more complex surface combatants in its shipbuilding plan, such as the DDG-1000 and the CG(X).

Submarines

The attack submarine force continues to be a major source of demand on the Navy's resources. Under the 2009 shipbuilding plan, the Navy would buy two attack submarines a year beginning in 2011. Under the Navy's 2007 and 2008 plans, it would begin buying two submarines a year in 2012. That procurement rate would continue through 2028 and then alternate between one and two submarines a year. The Navy's plan does not envision continuing to use guided-missile submarines beyond the 2020s, when the existing Ohio class SSGNs are to be retired from service.

Senior Navy leaders have stated—and the 2009 shipbuilding plan assumes—that the cost of Virginia class submarines would have to be reduced by about 15 percent, to around $2.4 billion each, before the Navy would be able to buy two per year.[19] The President's 2009 budget indicates a cost of about $2.9 billion for the Virginia class submarine purchased in fiscal year 2009.

CBO estimates that the Virginia class attack submarines built during the 2009–2038 period would have an average cost of $2.9 billion apiece. That cost is based on several factors—the prices that the Navy is currently paying for Virginia class submarines, the effects of producing two submarines per year starting in 2012, and the real cost growth affecting naval shipbuilding. In addition, CBO assumes that the average unit cost of the improved Virginia class to be built beginning in 2024 would be about 30 percent more than that of the original Virginia class, largely because of historical cost growth in the shipbuilding industry continuing through 2038.

In addition to the attack submarine force, the 2009 plan calls for a force of 14 ballistic missile submarines through 2026, with the force falling to 12 SSBNs by 2030. Although its stated requirement is for 14 SSBNs, the Navy's 2009 plan includes only 12 SSBNs, two less than the 2007 and 2008 plans. The Navy intends to buy its first replacement SSBN in 2019 and purchase one per year starting in 2024. The design, cost, and capabilities of that replacement submarine are among the most significant uncertainties in the Navy's and CBO's analyses. The Navy's 2007 and 2008 plans assumed that the first ship of a new class of ballistic missile submarines—an SSBN(X)—would cost $4.3 billion and that subsequent ships would cost about $3.3 billion each. The average cost for 14 SSBN(X)s would be about $3.4 billion. In contrast, the 2009 plan explicitly excludes the SSBN replacement as part of its costs, although it includes 12 of those submarines in its projection of future ship inventories.

Some senior Navy officials who oversee submarine programs have stated that the most cost-effective strategy for designing a new ballistic missile submarine would be to rely heavily on the design of the Virginia class. Much of the bow and stern of

19. The Navy's position is that to purchase two submarines per year in 2012, their cost would have to fall to $2.0 billion each in 2005 dollars, which is about $2.4 billion in 2009 dollars.

a Virginia class submarine, as well as the nuclear reactor, could be incorporated into the new SSBN. New missile-compartment sections would have to be developed, however, and integrated into the submarine's design. The practicality of that option has not yet been explored, and the Navy is only beginning to think about how to design an SSBN(X). No notional design or definitive estimate for the displacement of the SSBN(X) yet exists. Many Navy and industry officials involved with submarine warfare or submarine construction expect that the new ballistic missile submarine would be substantially smaller than the existing Ohio class submarines.

In its projections, CBO assumed that the Navy would buy 12 SSBN(X)s and that those submarines would be smaller than Ohio class submarines. CBO assumed that the SSBN(X) would be designed to carry 16 missile tubes (instead of 24 on existing submarines) and would displace around 15,000 tons submerged—making it roughly twice the size of a Virginia class submarine but nearly 4,000 tons smaller than an Ohio class submarine. On the basis of the larger size, what the Navy is currently paying for a Virginia class submarine, and cost growth in shipbuilding programs, CBO estimated that the average cost of the SSBN(X) would be about $7.0 billion. (A smaller design with only 12 or 8 missile tubes could cost $800 million or $1.5 billion less, respectively.) Therefore, CBO's projections include $84 billion that are excluded from the costs displayed in the Navy's 2009 shipbuilding plan (which excludes the costs of replacement SSBNs).

Amphibious Ships

The Navy's 313-ship requirement in its 2009 shipbuilding plan calls for a force of 31 amphibious ships organized around nine expeditionary strike groups. Each group would include one large amphibious assault ship (LHA or LHD class), one amphibious transport dock (LPD), and one dock landing ship (LSD). A footnote in the 2009 plan states, however, that the Marine Corps requires 33 amphibious ships in order to transport the assault echelons of two Marine expeditionary brigades and, therefore, the Navy is reviewing options to increase the number of amphibious ships to 33. To meet the Marine Corps's requirement for 33 ships over the 30-year period, the 2009 plan does not substantially increase the purchase of amphibious ships compared with the 2007 and 2008 plans, but it does assume an increase in the service life of two LPD-4s, two LHAs, and all 12 LSDs compared with the previous plans.

Specifically, the 2009 plan calls for the purchase of an LHA-6 in 2017 (in addition to the one being bought in 2007 and versions that would be purchased in 2010 and 2013 to be used in the Maritime Prepositioning Force (Future) squadron). The Navy would also buy seven replacements for the Wasp class LHDs in the 2020s and 2030s—designated the LH(X). In addition, 12 replacements for today's LSD-41 and LSD-49 class ships—designated the LSD(X)—which will start to reach the end of their service lives in the 2020s, would be purchased starting in 2016, at a rate of one every other year. The start of this program is two years earlier than in

the 2008 plan, but the 2009 plan slows LSD(X) procurement such that the last four ships of the class are purchased later than in the 2008 plan. The Navy's cost target for an amphibious ship in the 2007 and 2008 plans was $1.6 billion. That target was an average of the costs of the large LHAs and LHDs (which displace around 40,000 to 45,000 tons) and the smaller LSD replacements (which would probably displace 20,000 to 25,000 tons). The Navy has not provided comparable cost targets or other estimates for amphibious ships under the 2009 plan.

CBO assumes that all future amphibious assault ships will not be substantially larger than the first LHA-6, which is a variant of the existing LHD design. According to the Navy, its 2009 plan assumes that future large-deck amphibious ships will look a lot like the first LHA-6, which it is purchasing this year at a cost of about $3.4 billion. Under that assumption, CBO estimates the average cost of an amphibious ship—that is, the average cost for the LHA-6s, LHD replacements, and LSD(X)s—will be $2.8 billion.

The Navy's experience with its LPD-17 San Antonio class amphibious ship serves as a useful illustration of the rising costs of ships from one generation to the next on a per-ton basis. It also illustrates the difficulty in reducing those costs to levels that might meet the Navy's targets. The lead ship of the LPD-17 class is the most expensive amphibious ship on a per-ton basis ever built, at about $130 million per thousand tons. Thus, adopting either the LSD-41 or LHD-1 amphibious ships as analogies, historical cost-to-weight relationships would have understated substantially the actual costs of the LPD-17 (see Figure 4). Costs of subsequent ships of the LPD-17 class range from $1.5 billion to a little less than $1.7 billion, which are substantially higher than the Navy's original estimates.

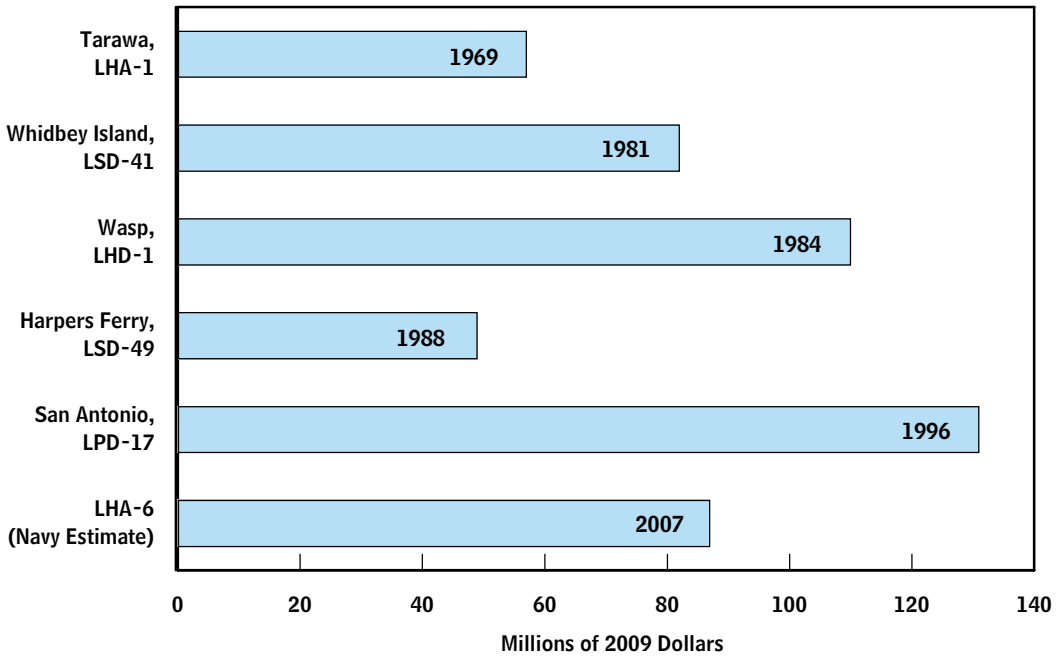
The Navy's 2009 plan states that in order to meet the Marine Corps's requirement for 33 amphibious ships, four ships would undergo a program to extend their service life. The costs of those extensions are not indicated in the 2009 plan, however. Likewise, CBO did not include the costs of those extensions in its estimates because little information is available about them at this time. Two Austin class LPD-4s will serve for 45 and 47 years, respectively, and two LHA-1 class amphibious assault ships will serve for 43 years. In addition, the decommissioning schedule associated with the Navy's 2009 shipbuilding plan indicates that the LSD-41 and LSD-49 class ships, which retire in the 2020s, will serve an average of 42 years, up from an average of 38 years in the 2007 and 2008 plans. Those ships may eventually require service life extension programs as well in order to serve more than 40 years in the fleet.

Maritime Prepositioning Ships

In a June 2005 report to the Congress, the Navy outlined the future of the Maritime Prepositioning Force. It described an MPF(F) squadron of 12 ships, most of which would be based on designs of existing amphibious or support ships. The squadron would include two LHA-6s; an LHD; three modified large, medium-speed roll-on/

Figure 4.

Cost per Thousand Tons for the Lead Ship of Various Classes of Amphibious Ships



Source: Congressional Budget Office based on data from the Navy.

Notes: The years shown here indicate the year in which each lead ship was authorized.

Costs are per thousand tons of lightship displacement (the weight of the ship itself without its crew, materiel, weapons, or fuel).

The LSD-49 is a variant of the LSD-41, and the LHA-6 is a variant of the LHD-8, the last ship of the LHD-1 class. The principal differences between the LHA-6 and the LHD-8 are that the LHA-6 will not have a docking well but will have enhanced aviation capabilities.

roll-off ships; three modified-design T-AKE support ships; three mobile landing platforms (large flow-on/flow-off ships to carry the squadron's landing craft); and two ships from existing maritime prepositioning squadrons. However, under the 2008 shipbuilding plan, the Navy opted in favor of using the existing T-AKE for the MPF(F) squadron, rather than a modified design. In the 2009 shipbuilding plan, the Navy has removed two of the three T-AKEs previously associated with the MPF(F) squadron but indicates that those two ships may be restored in its future shipbuilding plans. Consequently, the MPF(F) inventory under the 2009 plan is short two ships after 2020, when the squadron is expected to be ready for deployment. Further, as was noted earlier, the construction of most of the other MPF(F) ships was delayed in the 2009 plan by one to two years until the Navy and Marine Corps resolve issues regarding the concept of operations for the squadron. CBO estimates the cost of the MPF(F) squadron with only one T-AKE at about $14 billion.